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CONTRIBUTIONS TO OUR KNOWLEDGE OF AMERICAN CARBONIFEROUS FLORAS

X. An Osmundaceous Stem from Iowa[1]

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Somewhat over a year ago we received from Dr. L. R. Wilson a collection of coal balls which had been obtained from the coal mine of the What Cheer Clay Products Co., What Cheer, Iowa. The petrifactions contain some especially well-preserved plant remains, among them undescribed Pteridosperm stems, lycopod leaves, and other fossils that will be dealt with in future contributions. The subject of the present account is a fragment of a small stem which we believe to be a very early member of the Osmundaceae. Although the central part of the specimen is well preserved the outer cortical tissues, as well as the great cloak of petiole bases, so characteristic of the family, are missing. While this renders impossible a comparison with a few fossil genera known only from outer cortical tissue and petiole bases (*Bathypteris rhomboidea* and *Anomorrhoea Fischeri*, in Kidston and Gwynne-Vaughan, 1909), it does appear to represent a significant link in our knowledge of the family, or the complex from which it originated. Moreover, a rather careful search through the collection has failed to reveal additional specimens, and since the mine has been abandoned our only course seems to be to record such evidence as is available.

Kidston and Gwynne-Vaughan presented in a series of four papers (1907-10) a monographic treatment of the petrified stem remains of plants referred to the Osmundaceae. These fossils are from widely scattered localities and range in time from the Miocene down to upper Permian horizons. The specimen described herewith is believed to be sufficiently distinct to be designated as a new genus, and if our concepts of its relationships to the fossils of Kidston and Gwynne-Vaughan be correct it extends the range of the family back into upper Pennsylvanian times. Use of the taxonomic category "family" may be questioned with justification even though it is a rather remarkable series of fossils, and a few

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comments on the inter-relationships of the various genera will be offered following the description of the specimen.

Protoösmundites Wilsonii gen. et sp. nov.

The single specimen consists of a well-preserved siphonostele and a portion of what apparently was the inner parenchymatous cortex, including numerous leaf traces.

The wood is cylindrical, 2 mm. in diameter, there being no evidence of cambial activity (fig. 1). Within this is a well-preserved core of parenchymatous pith. As may be noted in the transverse and longitudinal sections (figs. 1, 2, 6), the pith cells are essentially isodiametric and uniformly thin-walled, no evidence of tracheidal pitting being apparent. Since the preservation is good there seems to be no doubt that we are dealing with a clearly defined siphonostele and a purely parenchymatous pith. This has an important bearing on the position that the fossil occupies in the Osmundaceae, a point that will be considered later.

The xylem is very slightly crushed but was apparently perfectly cylindrical in life, and approximately .5 mm. in radial thickness. It is composed entirely of scalariform tracheids[1], there being no admixture of parenchyma cells. The protoxylem elements appear as numerous, slightly extruding groups around the outer periphery. The first-formed cells are very nearly exarch, but their exact position is obscured by the imperfect preservation in this region and by the abundance of leaf traces. However, the latter appear uniformly centrarch immediately after their departure (fig. 5), and since they depart in such rapid succession it is not possible to distinguish protoxylems of the stele from those of the traces.

The protoxylem cells are markedly smaller than those lying immediately within and could not have been more than 2 or 3 cells of being exarch in position. The xylem cells range from 12 μ in diameter for the protoxylem elements to more than ten times as large for the largest (innermost) metaxylem cells. Two of the latter (fig. 1) measured 180 x 120 μ and 220 x 100 μ.

The secondary thickening of the tracheidal walls (fig. 4) is uniformly scalariform with the exception of the small outermost cells, which may best be termed annular. The latter differ from the metaxylem cells in that the secondary thickenings consist of finer rings and apparently lack any border.

[1]In Part III of their series on the Osmundaceae, Kidston and Gwynne-Vaughan state that the xylary elements in both recent and fossil species of the group are actually vessels since perforations exist between pits of adjoining cells, and Gwynne-Vaughan considered this problem more generally in another paper (1908). We are inclined to doubt that the perfection of preservation in all fossils assigned to the family allows positive determination on this point. Even though the central membrane did disintegrate with maturation of the cells, to apply the term vessel would be misleading since in other respects these cells are more closely comparable with normal scalariform tracheids of other vascular cryptogams and gymnosperms than with the vessels of the angiosperms.

The leaf traces departed slowly, forming a very acute angle with the stele, as is clearly shown in radial longitudinal sections (fig. 6). This is also indicated in transverse sections, where, at any one point, a large number of traces may be noted (fig. 1). It is unavoidable that most of the traces are cut more or less obliquely, yet where nearly perfect transverse sections are available it is clear that the protoxylem occupies a central position (fig. 5). The secondary thickening of the leaf trace elements is the same as that of the outer stelar cells, consisting of very fine annular bands (fig. 3).

Aside from the leaf traces, the only extra-stelar tissue that is preserved is a portion of the inner parenchymatous cortex, the cells of which are uniformly thin-walled and of essentially the same shape as those of the pith although considerably smaller (figs. 1, 6). The decayed area between this tissue and the xylem was probably occupied by phloem, pericycle, and the innermost border of the cortical tissue.

Diagnosis of Protoösmundites: Stem with a small siphonostele of nearly exarch protoxylem tracheids, large scalariform metaxylem tracheids, and a parenchymatous pith; no secondary wood and the primary wood composed of tracheids only; leaf traces small and numerous as in *Osmunda* with a central protoxylem, the cylindrical form of the trace being retained for some distance through the cortex.

Locality: Coal mine of the What Cheer Clay Products Co., one-half mile west of What Cheer, Iowa.

Horizon: Des Moines Series, Pennsylvanian.

Discussion:

The affinities of this fossil appear to lie with the early representatives of the Osmundaceae. In order to clarify our views concerning this probable position it seems desirable to review very briefly certain of the fossils described by Kidston and Gwynne-Vaughan in their monograph on the Osmundaceae.

Six species of *Osmundites* are described from widely separated localities extending from the Jurassic into early Tertiary horizons. In the lower Pliocene (or upper Miocene) *Osmundites Schemnitzensis* from Hungary, and O. *Dowkeri* from the lower Eocene of Herne Bay, Isle of Wight, the xylem cylinder consists of separate strands and surrounds a parenchymatous pith. These relatively recent species are strikingly similar to the modern members of the Osmundaceae. In the upper Jurassic O. *Kolbei* from Cape Colony a comparable xylary structure is present but of special note is the presence of irregularly shaped tracheids in the central tissue, the latter being, in fact, a mixed pith. In the Jurassic O. *Dunlapi* from New Zealand the stele differs from all of the more recent species in having a continuous xylary ring. However, as the central tissue was not present, it is not known whether it was strictly parenchymatous or mixed.

Still earlier genera which are assigned to the family, *Zalesskya* and *Thamno-*

pteris, from the upper Permian of Russia, possessed a stele that was differentiated into two xylary zones. In *Zalesskya gracilis* it consists of an outer ring of elongate tracheids and an inner zone of shorter, nearly square-ended, pitted elements. *Z. diploxylon* is similar, although the contrast between the two xylary zones is more marked, the elements of the central xylem being of relatively greater diameter, shorter, and with transverse walls. In *Thamnopteris Schlechtendalii* the central xylem consists of reticulately pitted cells in contrast to the more regular porose cells of *Zalesskya gracilis*. It should be noted that in all three of these species the centermost portion of the stele had been lost through decay. However, Kidston and Gwynne-Vaughan note that: "As regards *Zalesskya diploxylon*, at any rate, we feel convinced that the central xylem occupied the whole of the center of the stele in the living plant. Further, we accept the deduction suggested by this conclusion, *that the vascular anatomy of the Osmundaceae must be derived from a protostele with a solid central homogeneous xylem mass*." (II, p. 229).

This group of fossils, similar in the organization of their petiole structure, seems to present, through the evolution of a protostele to a specialized siphonostele, a clear-cut line of Osmundaceous ancestors going back to the upper Permian. Although *Protoösmundites Wilsonii* appears to lie closer to this alliance than any other series of ferns it is apparent that it does not fit perfectly into the sequence. If *Zalesskya* and *Thamnopteris* are typical of the family for the period one would expect, in this upper Pennsylvanian species, a somewhat less advanced parenchymatization of the pith. Furthermore, *Protoösmundites* differs from the previously described genera in that the scalariform thickenings of the xylary elements extend across the lateral wall rather than being separated into two or more series. It is not surprising, however, that in this earliest representative a somewhat simpler organization should prevail in this respect.

With regard to the leaf traces, it seems especially significant to note that *Osmundites skidegatensis* (Lower Cretaceous of British Columbia), considered to be the most advanced species, living or fossil, presents a leaf trace "very large, and it is already strongly curved, even while still in the parenchymatous inner cortex of the stem." (Kidston and Gwynne-Vaughan, 1907, p. 772). This is quite in contrast to the upper Permian genera *Zalesskya* and *Thamnopteris*, where the traces remain oval-shaped with a deeply immersed protoxylem for some distance through the inner cortex. Judging from a comparison of our specimen with Kidston and Gwynne-Vaughan's figures of these Permian genera the retention of the centrarch form of the trace is even more pronounced in the Iowa fossil. While further comments can be little more than speculative it appears that the petiole structure in *Protoösmundites* is distinctly primitive, pointing to a frond that was correspondingly less specialized in its general morphology. Until further evidence may confirm or refute it we are inclined to look upon this fossil as either an early representative of the Osmundaceae proper or a member of an associated line leading up from the Coenopterid complex.

Acknowledgement:

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References cited:

Gwynne-Vaughan, D. T. (1908). On the real nature of the tracheae in the ferns. Ann. Bot. 23:517–523.

Kidston, R., and D. T. Gwynne-Vaughan (1907-1910). On the fossil Osmundaceae. Part I. Roy. Soc. Edinb. Trans. 45:769–780. 1907; Part II. *Ibid.* 46:213–232. 1908; Part III. *Ibid.* 651–667. 1909; Part IV. *Ibid.* 47:455–477. 1910.

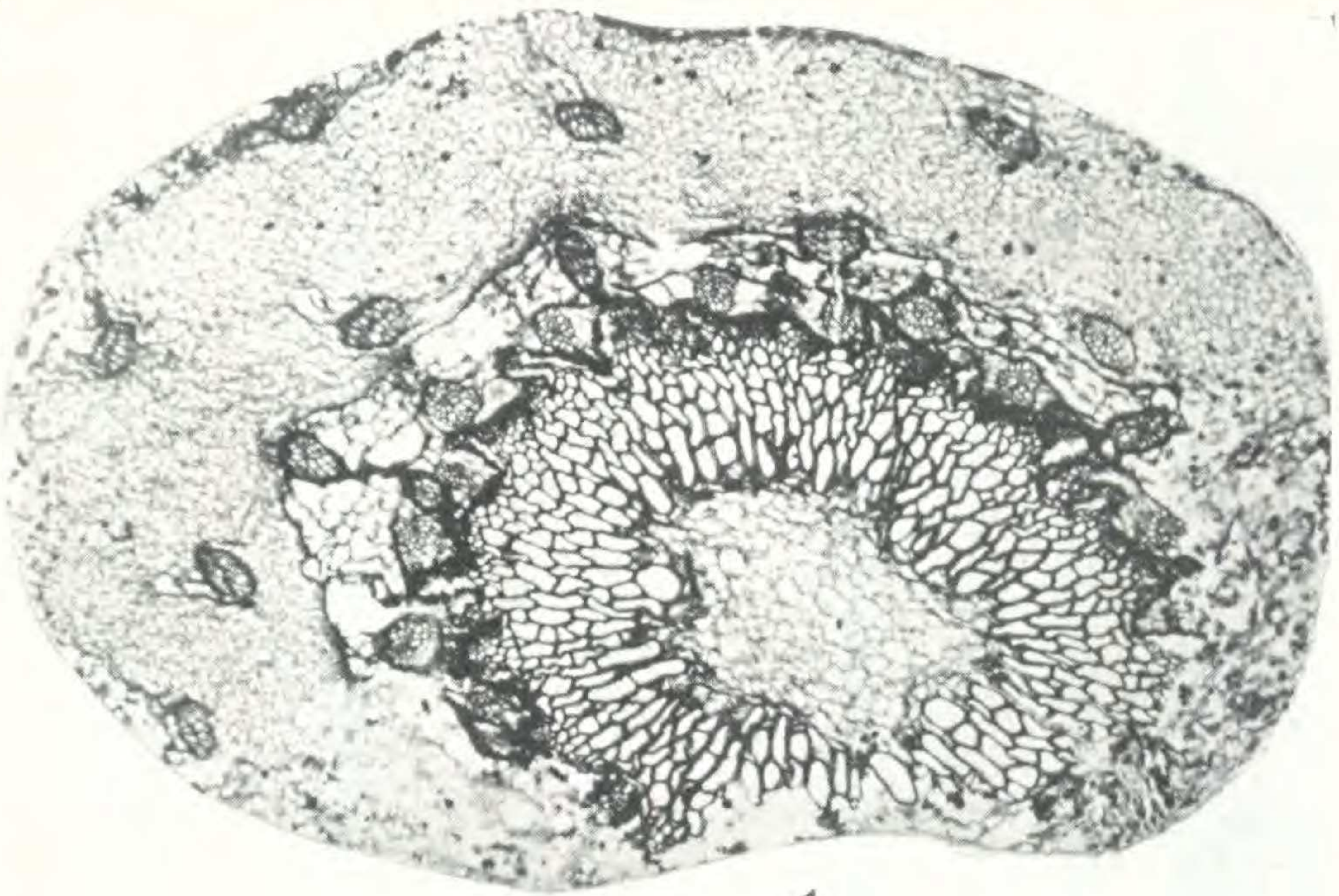
EXPLANATION OF PLATE

PLATE 9

Protoösmundites Wilsonii

Fig. 1. A transverse section of the specimen showing central pith, wood, leaf traces and parenchymatous cortex. Slide 1521, × 21.

Fig. 2. A radial longitudinal section showing the scalariform nature of the xylem elements: *p*, pith; *m*, metaxylem; *px*, protoxylem. Slide 1518, × 100.



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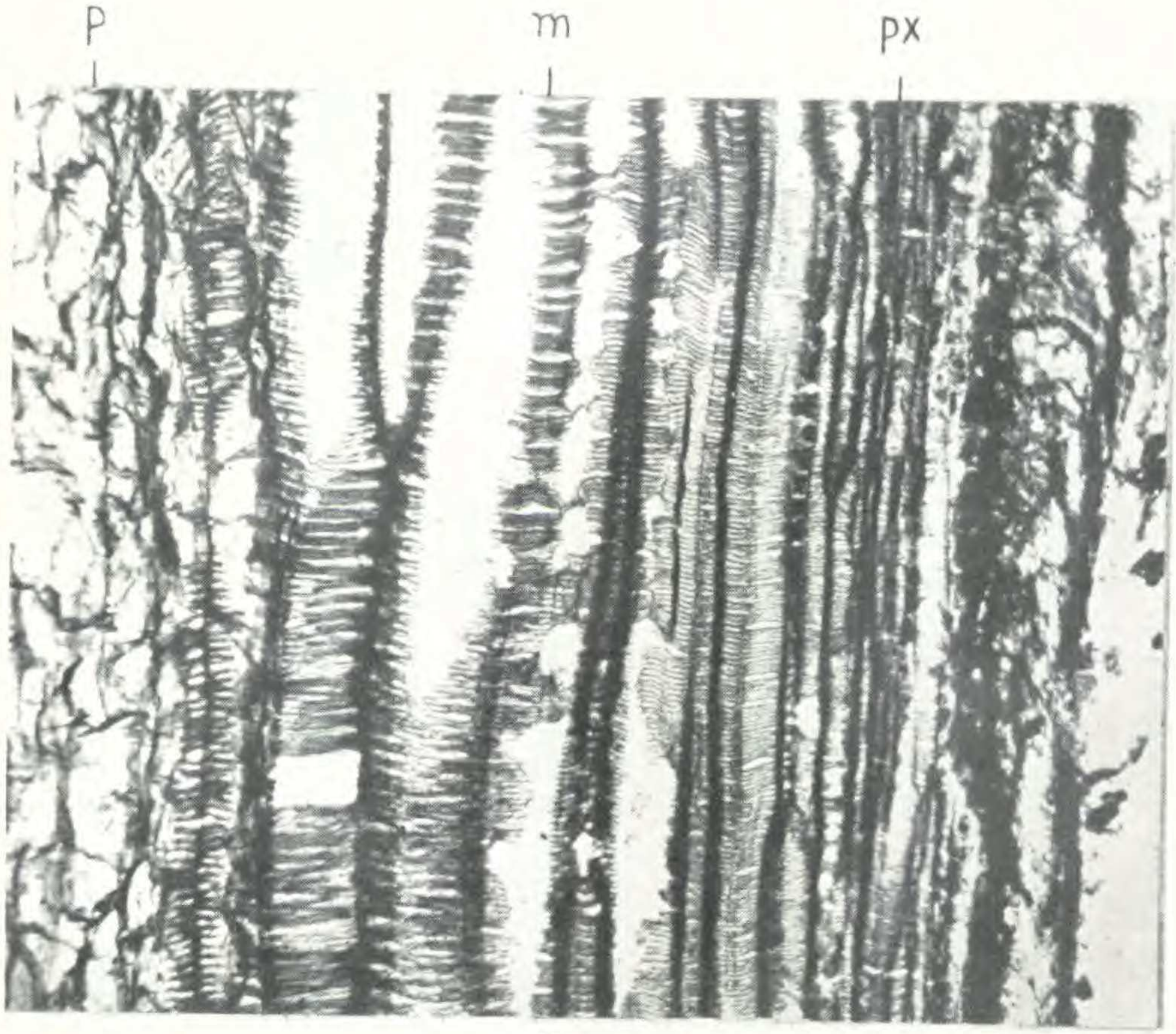

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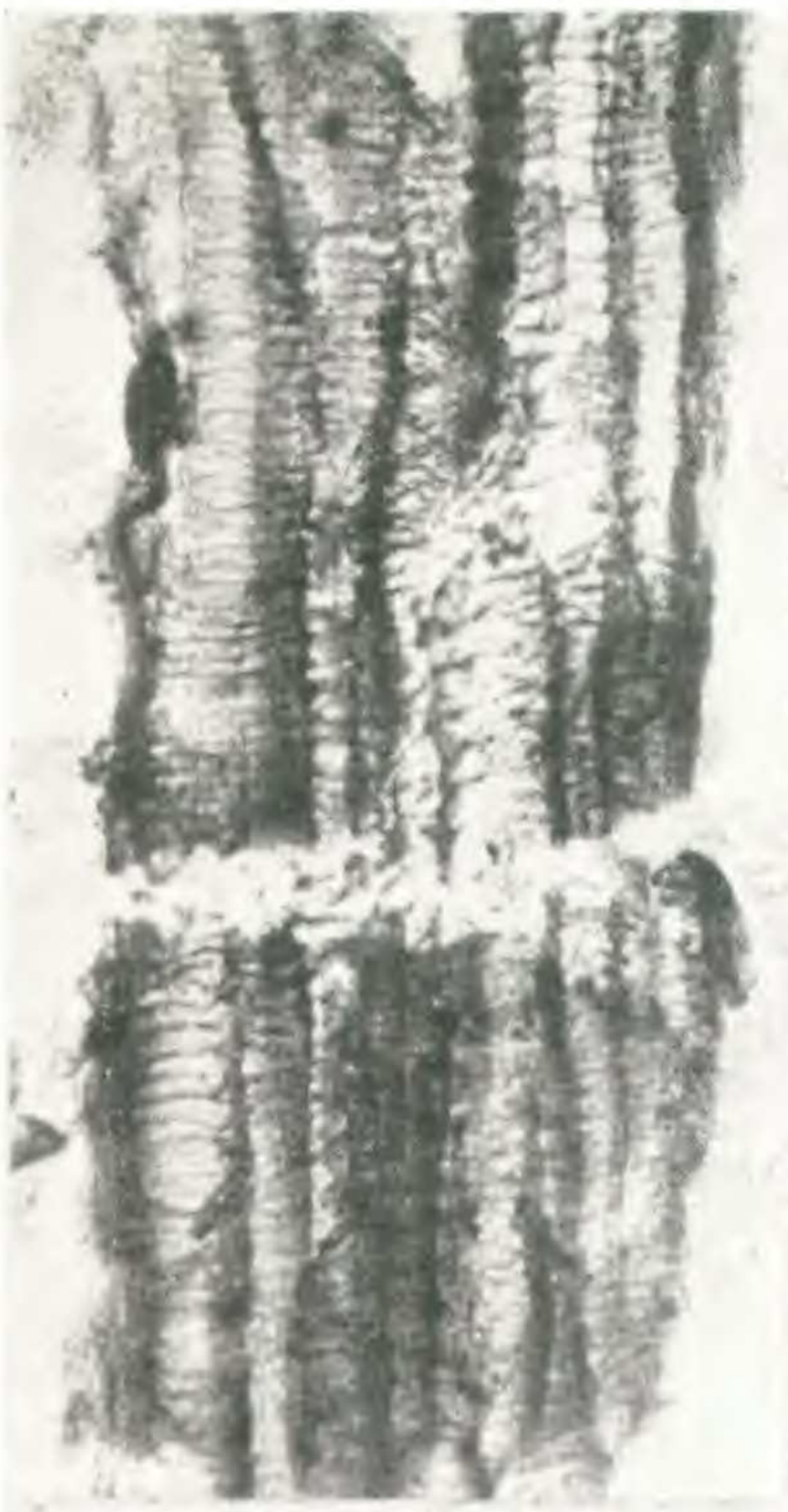
ANDREWS & BAXTER—*PROTOOSMUNDITES WILSONII*



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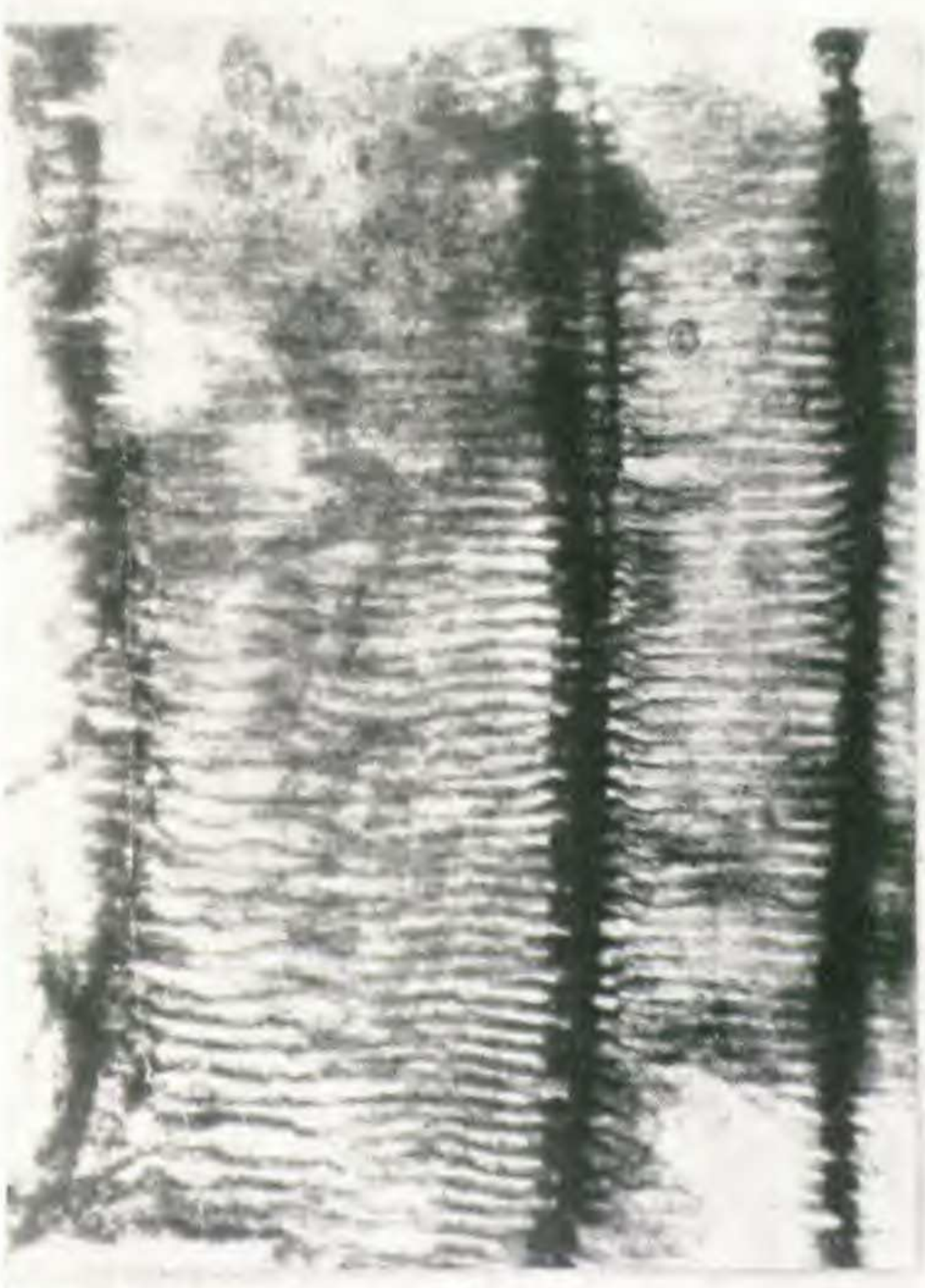

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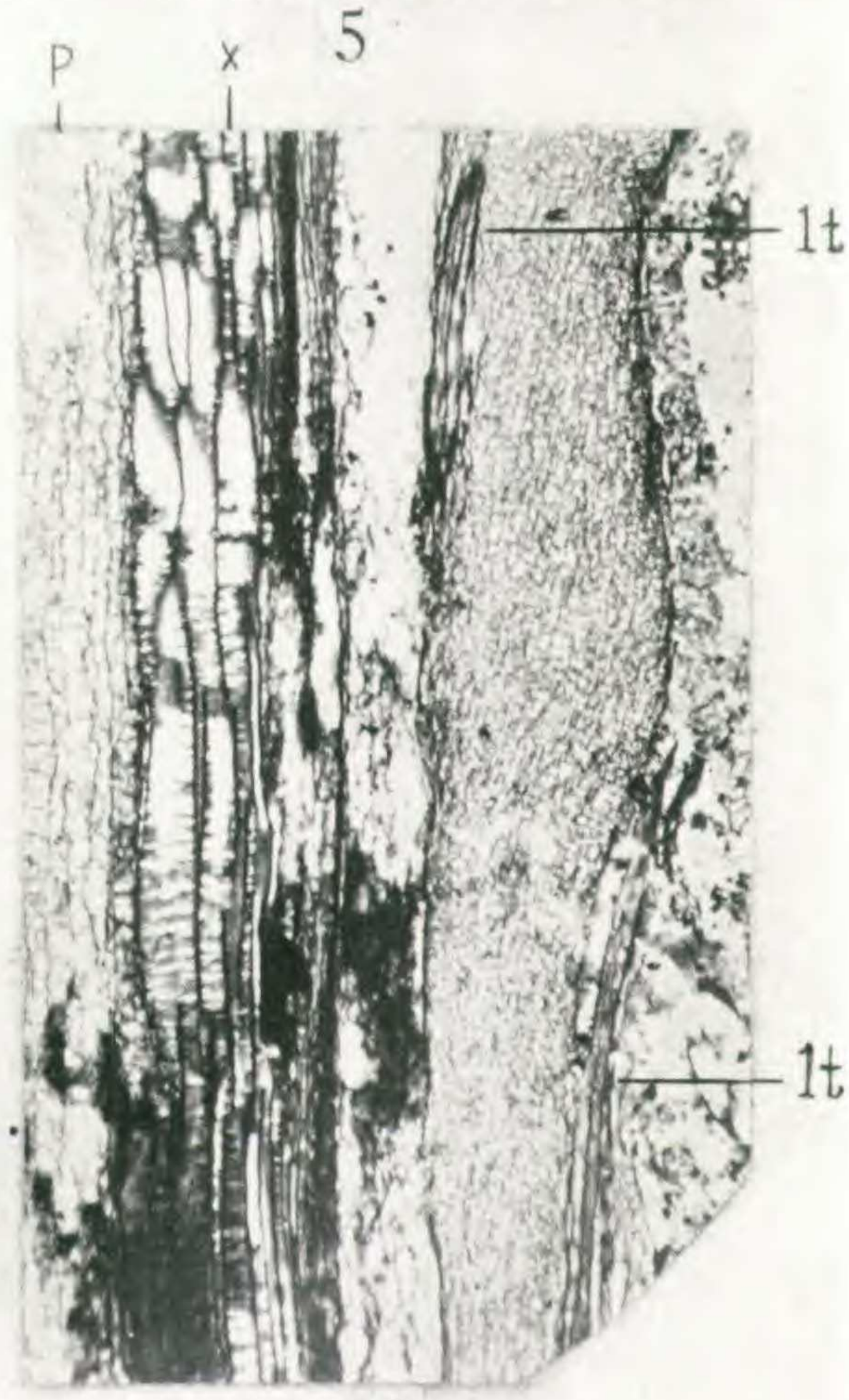

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ANDREWS & BAXTER—*PROTOOSMUNDITES WILSONII*

Explanation of Plate

PLATE 10

Protoösmundites Wilsonii

Fig. 3. A leaf trace in longitudinal section showing the fine annular thickenings. Slide 1518, × 300.

Fig. 4. Radial view of two metaxylem tracheids. Slide 1515, × 210.

Fig. 5. A leaf trace shortly after its departure from the stele: *px*, protoxylem. Slide 1520, × 230.

Fig. 6. A radial longitudinal section through the stem: *p*, pith; *x*, xylem; *lt*, leaf trace. Slide 1514, × 11.